GROUP EFFECTIVENESS RESEARCH LABORATORY
DEPARTMENT OF PSYCHOLOGY
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URBANA, ILLINOIS

THE INFLUENCE OF LEADER-KEYMAN RELATIONS
ON COMBAT CREW EFFECTIVENESS

Fred E. Fiedler
Technical Report No. 9

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Two studies dealing with the prediction of team effectiveness are here reported. These studies investigated the relationship between the formal leader's interpersonal perception and his team's operating efficiency. The samples under investigation consisted of B-29 Bomber crews and Army Tank crews. The former served primarily for exploratory purposes while the tank crews were used as a validation sample. The research has been based on the working assumption that relevant interpersonal relations can be inferred from standard sociometric procedures and from interpersonal perception tests measuring Assumed Similarity (AS) which will be described below.

Background

The research program of which the present studies are a part aims to discover some of the psychological principles underlying group productivity. We shall summarize briefly the earlier work which led to the present investigations.

Measurement of Assumed Similarity. We have measured interpersonal perception with the score, "Assumed Similarity between Opposites," or ASo. This score is obtained when we ask a subject (S) to fill out a personality questionnaire under two different sets: to predict (a) the responses of a person with whom he can work very well,

and (b) the responses of the person with whom he finds it most difficult to cooperate. The difference score D (2) indicates the similarity subject (S) perceives between his most and least preferred work companions. A person who perceives his most and least preferred work companions as similar has high Assumed Similarity (ASo); a person who perceives marked differences between them has low ASo.

The split-half reliability of ASo scores ranges between .85 and .95 for a 60 item questionnaire (3).

Despite numerous attempts, we have not found ASo scores to correlate consistently with traits measured by other personality inventories. Assumed Similarity appears to measure some aspects of emotional distance. A person who perceives others to be similar (has high ASo) seems to desire closer emotional relations than a person who perceives others as dissimilar. Scattered findings and interview data further suggest that the person with high ASo is essentially acceptant, pliable, and receptive and is inclined to be uncritical of others. A person having low ASo appears to be a more critical, reserved, and analytic individual who rejects those with whom he cannot work (5).

The Relations of ASo to Effectiveness of High School Basketball Teams

We first utilized ASo in two studies of informal teams (4, 5). A frankly exploratory study investigated 14 high school basketball teams at the beginning of the season. These teams consisted of from 9-18 men each. ASo scores and sociometric preference ratings, by which we could identify the team's "most preferred co-worker," were obtained from each S. Team effectiveness was defined as the proportion of games the team had won by midseason.

As shown in Table 1, we found a correlation of -.63 between ASo

of the team's most preferred co-worker and the criterion. In other words, teams which chose a low ASo person tended to be more effective than those preferring a high ASo co-worker.

Seven good and five poor teams, tested at the end of the season, were used as validation sample. A significant correlation between ASo and the criterion (-.58) corroborated our original finding (5).

Relation of ASo to Effectiveness of Student Surveying Parties

The results on basketball teams were cross validated in a second study of informal teams. Members of 22 surveying parties participated in this study. These 3 to 4 man teams consisted of civil engineering students taking a required field course in surveying.

We again obtained ASo scores and sociometric preference ratings from each S. The criterion consisted of instructor ratings of team accuracy.

The hypothesis was supported that ASo of the team's most preferred co-worker (i.e., its informal leader) is negatively correlated with team effectiveness (Table 1) (5). The findings were interpreted to indicate that effective teams chose informal leaders who perceive many differences between their co-workers. The present report extends the earlier research to formally organized teams.

Work with Formal Teams: B-29 Bomber Crews[*]

Hypotheses

The team effectiveness of informal teams was correlated with the ASo score of only the team's most preferred co-worker, i.e., its informal leader. For this reason we believed psychological

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[*] The groups used in this study also provided data for a project sponsored by the Crew Research Laboratory of AFPTRC. We are indebted to Dr. Robert L. French, Director of Research, CRL, and Dr. Thornton B. Roby, Chief, Crew Assembly Section, for their cooperation.

distance (as measured by ASo) to be an attitude related to effective
leadership. We therefore hypothesized that the ASo score of formal
leaders would also be negatively related to crew effectiveness
criteria.

Table 1

Correlations of Teams' Most Preferred Co-workers'

ASo Score with Criteria of Effectiveness

Sample	Correlation	N	P
High School Basketball teams tested pre-season	-.63*	14	.05
High School Basketball teams tested toward end of season	-.58**	12	.05
Student Surveying Teams	-.51***	22	.02

* Spearman Rho

** Point biserial, significance tested
with student's t. (one tailed)

*** Pearson r. (one tailed)

However, several studies have pointed out that groups may
have informal as well as formal leaders (1, 11, 12). In cases where
the formal leader is not also the informal leader, his influence over
the group is considerably weakened. Hence, a special case of the
first hypothesis stated that the ASo score of the accepted leader
(i.e., who is informal leader or most preferred crew member) would be
correlated with effectiveness criteria.

Procedure

Sample. Seventy B-29 crews, from four different training classes, were available for this study. Each class contained 17 or 18 B-29 crews.

Crew Structure. A B-29 crew normally consists of 11 men. Five are officers: The Aircraft Commander (AC), Pilot (P), Navigator (N), Radar (or Video) Observer (VO), and the Bombardier (B). Six are enlisted crew members: the Flight Engineer, Radio Operator, and four gunners.

Assumed Similarity Tests. ASo scores were obtained from all crew members who were available for testing. The test consisted of 80 items, such as the following: "I am often bored with people", and "It annoys me to leave a task unfinished."

The test instructions asked S to predict the responses of the man in the Air Force with whom he had worked best, and the responses of the man with whom he had worked least well. The test was given during two sessions four weeks apart. Reliability for ASo in the 80 item test was obtained by the Guttman Split-half formula and is .86 for one class (N = 178).

Sociometric Questionnaires. Sociometric preference ratings were derived from a routinely administered "Position Description Form", which asks Ss to indicate the persons on their crew whom they would definitely prefer, moderately, or least prefer for five crew activities. These activities are, (a) organizing a crew party, (b) going on leave, (c) going on a dangerous mission, (d) loading special cargo, and (e) returning with the crew from behind enemy lines.

Responses to these five questions were highly intercorrelated; a pooled preference score was therefore computed which indicated the extent to which a crew member chose various others on his crew. Because we were particularly interested in relative sociometric choices, the preference ratings were converted to ranks within the crew.

Criterion Scores.

Two criteria of bomber crew effectiveness were originally used. Both were developed by the Crew Research Laboratory, Randolph Air Force Base.

Radar Bomb Scores - Circular Error Average (RBS). This measure is an error score indicating how far off the target a particular bomb would theoretically have fallen. The score is computed as the average for 10 missions. According to the Crew Research Laboratory the reliability of RBS is .4 to .6.

Control Time Error (CTE). This is also a theoretical score which indicates the number of minutes by which a plane would be too early or too late at a certain predetermined point of meeting. According to the Crew Research Laboratory, the Navigator (N) accounts for most of the variance of this score.[*] The reliability of CTE is approximately .5 to .6. The correlation between RBS and CTE as computed by the Crew Research Laboratory is -.16 ($N = 100$). RBS and CTE are thus independent criterion scores.

Tests of A Priori Hypotheses

One hypothesis of the study stated that ASo of the Aircraft

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[*] Dr. T. B. Roby, Personal communication.

Commander (ASo_{AC}) would be negatively correlated with criteria of crew effectiveness. This hypothesis was not supported. ($r = -.24$)

A subsidiary hypothesis stated that ASo_{AC} would be negatively correlated with crew effectiveness criteria in crews in which the Aircraft Commander was most preferred crew member (AC = MPC). This hypothesis was also not supported. In fact, we found a positive correlation of .62 (N = 22, $P < .01$) between Control Time Error and the ASo score of accepted (most preferred) Aircraft Commanders.

Relations of ASo to Radar Bombing

General Considerations. Since the a priori hypotheses had yielded negative results we used the bomber crew data for further exploratory work. Hypotheses derived from these data were then tested on a sample of Army Tank crews.

In our exploratory work on Air Force crews we decided to work with the radar bombing criterion since it reflects one of the most important functions of B-29 crews. Radar bombing is also considered to be more nearly a crew product in contrast with Control Time Error which depends almost entirely on the Navigator.[*]

Sociometric relations. Our studies of informal groups had considered the sociometric relationship within the crew, since we correlated only the ASo score of the informal leader (the most preferred co-worker) with effectiveness criteria. Although the hypothesis that the ASo of the "accepted" Aircraft Commander would correlate with Radar Bomb Scores was not supported we explored further whether ASo of the Aircraft Commander might

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[*] Dr. T. B. Roby, Personal communication

correlate with radar bombing under still more clearly defined sociometric conditions.

In particular we considered the accepted leader's relations with his keymen, i.e., the specialists on his crew who are most directly concerned with criterion relevant tasks in radar bombing. These keymen are the Radar Operator (VO) and the Navigator (N), both of whom have radar equipment and perform related tasks during RBS runs.

Results. Tables 2, 3, and 4 present the results of this exploratory work. As can be seen, high negative correlations were found in two related sociometric conditions. In the first of these the Aircraft Commander is Most Preferred Crew Member and endorses one or both of his keymen[*] (AC = MPC $--\to$ VO and/or N), (Tables 2 and 3).

Where the accepted Aircraft Commander does not choose his keyman, ASo and Radar Bomb Scores tend to be positively correlated. A second related method selects crews in which Aircraft Commander and keymen mutually choose each other. Here again ASo_{AC} correlates negatively with the criterion. (Table 4) To judge from the magnitude of the correlations this is apparently a less powerful method but it has the advantage of utilizing a somewhat greater number of crews. It is based on the assumption that

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[*] Sociometric endorsement was arbitrarily defined by the ranks 1 to 2 for high choice ($--\geqslant$), 2.5 to 3 for medium choice ($---$), and 3.5 - 10 for rejection ($-\!\!\not\!\geqslant$). These breaking points are in part based on the desire to divide the groups into three equal sub-samples; however, it does not seem reasonable to assume that a person tied with two others for first choice, or chosen as second most liked, is someone toward whom the AC is indifferent. A compromise was here made by considering the second rank as still indicative of high preference, even though this makes the highly liked group somewhat larger than the other two sub-groups.

Table 2

Correlation of the Aircraft Commander's ASo Score with Radar Bombing
Criterion under Selected Sociometric Relations between
the Aircraft Commander and the Keymen

Sociometric Condition	Rho	N	P
AC = MPC --> VO/N	-.81	11	(.01)*
-- VO/N	.13	7	—
-/> VO/N	.42	7	—
AC ≠ MPC --> VO/N	-.03	18	—
-- VO/N	-.80	5	—
-/> VO/N	-.67	7	—

AC = Aircraft Commander	--> High sociometric choice
VO = Radar Observer	-- Neutral sociometric choice
MPC = Most Preferred Crew Member	-/> Low sociometric choice

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* As this study explored many hypotheses, tests of significance
are not interpretable.

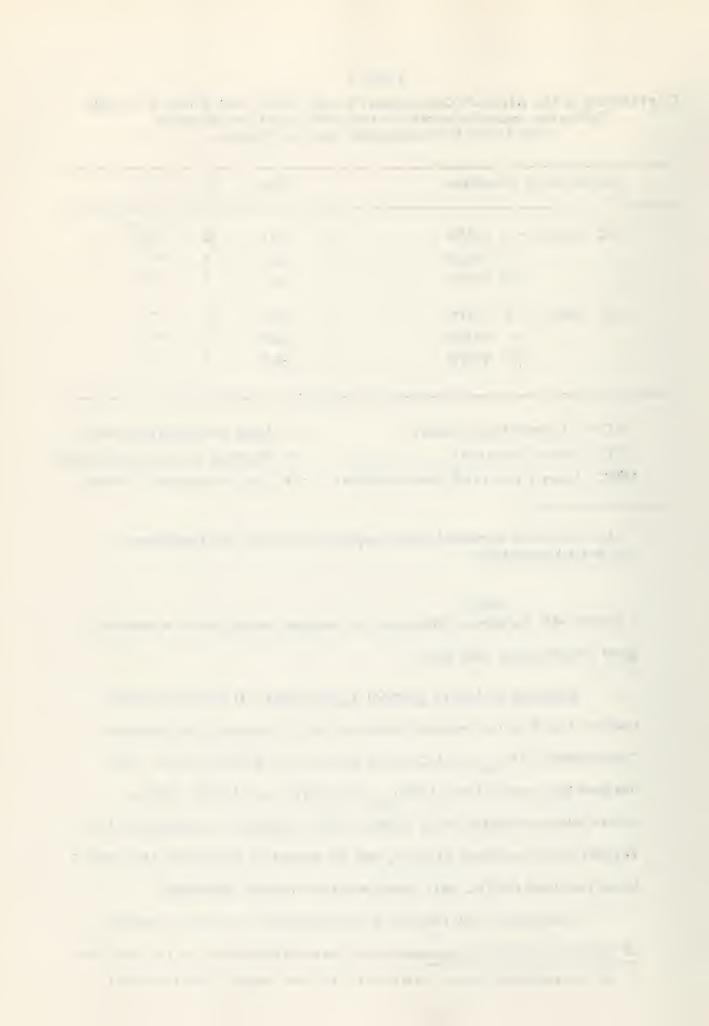   better
a leader will be/able to influence his keymen when he has a mutually

good relationship with them.

Relation of ASo to Control Time Error. It will be recalled

that we found no correlation between the ASo score of the Aircraft

Commander (AC_{ASo}) and Control Time Error (CTE) (.16, N = 51)

but that the correlation of ASo_{AC} with CTE was .62 (N = 22) in

crews which accepted their leader. This relation is contrary to the

results of all previous studies, and we therefore compared the opera-

tions involved in CTE with those related to radar bombing.*

Interviews with former B-29 personnel, as well as perusal

of various manuals, suggested some basic differences in the Aircraft

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* As we indicated above, RBS and CTE are uncorrelated scores.

Table 3

Correlation of the Aircraft Commander's ASo Score with
Radar Bombing under Different Sociometric Conditions

Sociometric Condition	K = Radar Operator			K = Navigator		
	Rho	N	P	Rho	N	P
AC = MPC -> K	-.76	8	(.05*)	-.93	9	(.01)*
-- K	-.05	8	—	.43	10	—
/> K	-.05	9	—	.89	6	(.05)*
AC ≠ MPC -> K	.03	15	—	.05	8	—
-- K	-.13	7	—	.36	10	—
/> K	-.56	10	—	-.11	12	—

AC = Aircraft Commander   -> Positive sociometric choice

MPC = Most Preferred Crew Member   /> Negative sociometric choice

K = Keyman   -- Neutral sociometric choice

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* See Footnote to Table 2

Commander's relationship with his Navigator as against that with
other crew members. The AC-Navigator relationship seems to be
unique in approaching that of an advisee to an expert advisor. The
Navigator is charged with collecting and integrating various naviga-
tional data and he then advises the Aircraft Commander on the approp-
riate course heading. While the AC ordinarily is supposed to follow
his Navigator's directions during the operations relevant to CTE,
Aircraft Commanders vary in their willingness or ability to do so,
especially since the AC is allowed considerable latitude in using his
judgment, and may even disregard the Navigator's advice if he
so desires.

Table 4

Correlation of the Aircraft Commander's ASo with the Radar
Bombing Criterion in Crews in which the AC
Reciprocates his Keymen's Choices

Sociometric Condition	Rho	N	P
AC ←→ VO and/or N	-.48	22	(.05)*
AC ←/→ VO and/or N	.05	27	

* See footnote to Table 2

On the basis of these considerations we decided that
Control Time Error represents a special case which will need to
be further explored when appropriate groups are available. It
leads to the hypothesis that high ASo on the part of accepted leaders
will facilitate . decision making or problem solving by groups in
which the leader is dependent for information and advice on his
subordinates. Our data suggest that CTE requires a different type
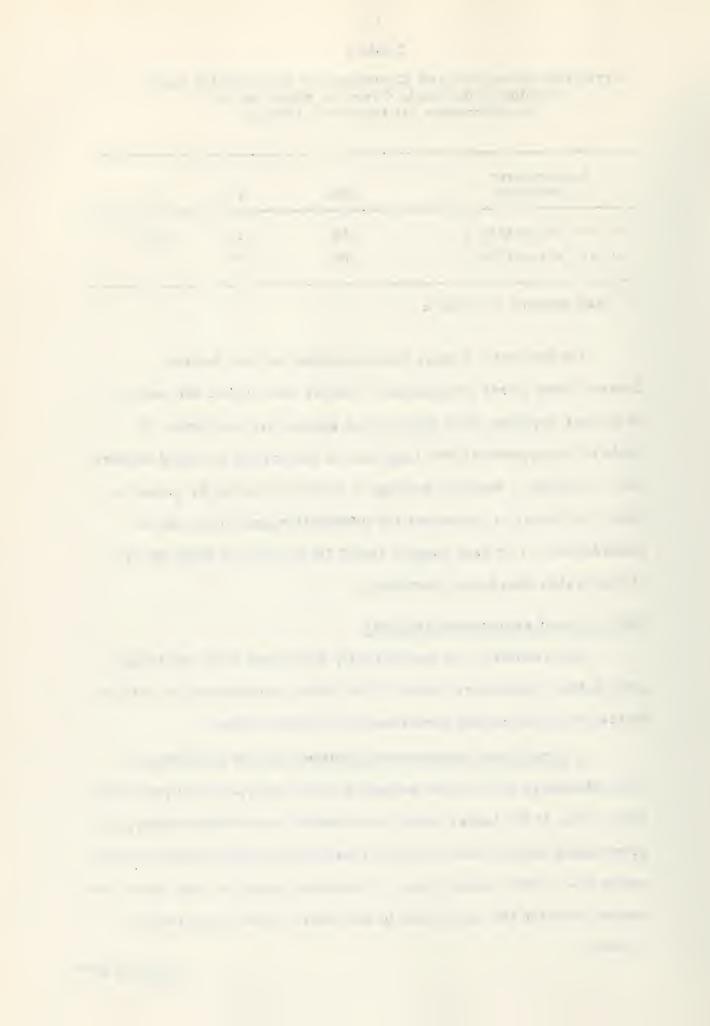of leadership than Radar Bombing.

Discussion of exploratory analyses

Our rationale was concurrently developed with, and in part
guided, this exploratory work. It has led to a consideration of three
factors which affect the performance of formal teams.

A generalized interpersonal attitude toward co-workers.
This attitude is presumably reflected by the interpersonal perception
score ASo. If the leader's ASo is related to team effectiveness, this
generalized interpersonal attitude must in some way influence others
on the crew. The variable thus becomes operative only under con-
ditions in which the leader can in fact exert positive and negative
influence.

The leader's relations to his keymen. A formally organized team, such as a bomber crew, is composed of specialists. Most objective criteria of team effectiveness are primarily a function of a limited number of these specialists. The leader must then influence these specialists or keymen in order to affect the corresponding performance criterion. For example, to affect crew effectiveness in radar bombing, the Aircraft Commander's attitude must influence the Radar Operator and/or the Navigator who have radar equipment, not some other crew members, such as the Gunners, who have very little influence in radar bombing, but who may be keymen for a different criterion.

The leader's status. The leader's attitude, here measured by ASo, will strongly affect the keyman's behavior only under certain conditions of group structure, namely when the leader has power in the group which allows him to apply formal or informal sanctions to influence his keymen.

We may note in passing that the condition $L = MPC \dashrightarrow K$, (i.e., accepted leader endorses his keyman) closely parallels the group structure in informal teams. It will be recalled that ASo of the leader correlated negatively with group effectiveness in informal teams. The formal and informal leadership is, of course, identical where the formal leader is also most preferred crew member (18). In common with most informal teams, our informal groups did not consist of specialists and any team member could thus be a keyman. As Whyte has pointed out, this is usually the person whom the informal group's leader chooses and respects most highly (19).

Promising relations were also found for crews in which the Aircraft Commander was most preferred crew member (MPC)

and rejected his keymen (AC = MPC $-\not\rightarrow$ K). Since these relations did not reach the 5% level in the exploratory study, the formal hypotheses for the validation study were not based on them. We shall, however, return to these relations in a forthcoming section of this paper.

Ancillary Validation Study: Visual Bombing Accuracy

The exploratory work with the radar bombing criterion led to the main hypothesis that ASo of the formal leader will be negatively related to the criterion under specified sociometric relations: Namely, where (a) the leader is most preferred crew member and endorses the keyman, or (b) the leader and keyman endorse each other.

The present analysis was made after the major validation study on tank crews. It is presented at this point for the sake of simplifying the report.

Criterion. One criterion of visual bombing accuracy which is independent of RBS ($r_{RBS.\%SVC}$ = .08, N = 100) is the percent of satisfactory camera bombing runs. The reliability of this criterion has been reported as ranging from zero to .54, for ordinary missions (14). Because it is currently not considered satisfactory[*] by the Crew Research Laboratory it was not part of our original study.

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[*] The Percent Satisfactory Visual Camera Runs (%SVC) criterion is unsatisfactory from a statistical point of view since approximately 50% of the crews obtained 100% SVC. The distribution is therefore highly skewed and the correlations with this criterion can only be interpreted as roughly indicating the direction of the relationship.

Procedure. The analysis utilized the same sample of B-29 crews as reported above. The relationship of the Aircraft Commander's ASo to the visual bombing criterion was investigated for crews in which (a) the accepted Aircraft Commander endorses the Bombardier, and (b) the Aircraft Commander and Bombardier endorse each other.

Results. The results, while not significant, were consistent in direction with those found using the radar bombing criterion. These relations thus represent further corroborative evidence when considered in the context of the entire investigation. (See Table 9)

Main Validation Study: Tank Crews [*]

The two related hypotheses which emerged from the bomber crew study were tested on a sample of 25 tank crews which participated in Project STALK (Cf. 10).

Procedure

Background. The Ballistics Research Laboratory of the Ordnance Corps, and the Office of the Chief of Army Field Forces jointly conducted "Project STALK" in the Fall and Winter of 1953 to determine the relative effectiveness of five models of tanks. The present study supplements this Army experiment by attempting to determine the psychological factors which influence the relative effectiveness of tank crews. The specific results and procedures of Project STALK are classified insofar as they pertain to the operation and performance of equipment. For this reason they have

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[*] This study was made with permission of the Director, Ballistic Research Laboratories, Aberdeen, Md., and Mr. Floyd I. Hill, Technical Director of STALK. We are especially indebted to Messrs. Hill, Andrew J. Eckles, III, and Stanford C. Ericksen, whose active collaboration enabled us to conduct this study.

been deleted from this report.

Subjects. Twenty-five tank crews from a fairly typical battalion served as subjects. Their scores on the Army General Classification Test ranged from 58 to 139 with a mean of 90.6. Of the 142 men who participated in this study, about 30% had completed no more than eight years of school.

Crew Structure. Each crew consisted of the following 5 men:

Tank Commander (TC), in charge of the crew

Gunner (G)

Driver (D)

Loader (L), who also assists the Gunner

Bowgunner (BG), who also assists the Driver. Under some conditions the bowgunner did not participate as a member of the crew.

Several alternate crew members were also tested.

Design of STALK. The experiment was designed as a Graeco-Latin Square. Each platoon, consisting of five crews, worked with a different one of five tank models in each of the five phases of the experiment. Criterion scores for our purposes could thus be obtained by comparing crews within a platoon during one particular phase, or by comparing all platoons over all phases.

Test Instrument. Similarity scores were obtained as in the bomber crew study. The AS test contained 60 items selected from among the 80 items of the test used in the B-29 study; it was administered one week before the experiment.

The split-half reliability of ASo scores, derived from this 60 item instrument, was .91 (N = 132).

Sociometric Questionnaire. Sociometric questionnaires were administered to the tank crews on three occasions. Ss responded to the first questionnaire just prior to the beginning of the experiment, to the second at the beginning of the fifth phase (three months later), and to the third questionnaire in the week after completion of the project, almost four months after the first administration.

The first and second questionnaires asked each crew member to rank in order of preference seven men in his platoon for three situations: (a) men S would want to have as fellow crew members under combat conditions (b) men he would be likely to nominate for battlefield commissions, and finally (c) men with whom S was on friendliest terms. The third questionnaire used the same stimulus questions but differed from the first two by asking for the five most preferred, and five least preferred men in the platoon.

Inspection of the questionnaires indicated high intercorrelation of responses to the three sociometric stimulus questions and we therefore averaged the responses to the three questions. Responses on the three questionnaires could then similarly be averaged and "combined" into one sociometric preference rating. This "combined" rating was used in connection with analyses which considered the average criterion performance rather than subcriteria obtained within a "Phase".

Criteria of Crew Effectiveness

Each crew competed with other crews of the same platoon during each of the five phases. Thus, each crew within the platoon can be ranked with respect to other crews within the same platoon. It is not feasible, however, to rank crews of different platoons on the same tank models since the crew which worked with Tank Model

A during a late phase would have had more experience in handling tanks and in working together than crews which worked with Tank Model A during an early phase of the experiment.

Three criteria which are described below were used for our study. These were obtained by personnel of the Office of the Chief of Army Field Forces and the Ballistics Research Laboratory and are based on test results from 25 different targets.

1. Time per Hit (T/H) is the average time in seconds which a crew required to hit 5 assigned targets in each phase. This score depends primarily on the gunner. The Time per Hit can be obtained for each of the five phases (T/H_I, T/H_{II}, etc.) and also as the sum over all phases ($\Sigma T/H$). (This treatment also applies to Travel Time.)

2. Travel Time(T/T) is the average time of travel from target to target on the course. It is a score which largely reflects the driver's skill and ability in handling the tank.

3. Probability of a crew winning an engagement (F_A). This is a composite criterion score which indicates the probability that a particular crew will win a duel with a similar tank.[*]

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[*]   The score is based on the formula

$$P_A = \left[1 - P_m(A)\right] \int_{t_4(A)}^{\infty} h(t_{34})dt \neq P_m(A) \int_{t_4(A)}^{\infty} g(t_{24})dt$$

Where P_A = Probability of crew A winning the engagement

$P_m(A)$ = Fraction of all crews having travel time to target greater than travel time of crew A

$g(t_{24})$ = Frequency distribution of time of all crews from target-in-view till hit

t_2 = Time target comes in view

t_3 = Time target is recognized

t_4 = Time target is hit.

The formula weights the gunnery performance more highly than other criterion performances and we have therefore considered the Gunner (G) as the keyman for this criterion performance.

As indicated by Table 5, with exception of Time per Hit and P_A, the average criterion scores (summed over all phases) are uncorrelated.

Table 5

Intercorrelations of combined criteria of
Project STALK (N = 25 crews)

	Σ T/H	Σ T/T	P_A
Σ T/H	-	-.07	.69**
Σ T/T		-	.10
P_A			-

** $P < .01$

Σ T/H = Average Time per Hit

Σ T/T = Average Travel Time

P_A = Probability of Tank A winning
an engagement

Operational Hypotheses

As indicated above we tested the hypothesis that ASo of the formal leader will correlate negatively with the criteria in crews having certain sociometric structure.

Stated as operational hypotheses, these read:

1. a. ASo of the Tank Commander (ASo_{TC}) will correlate negatively with Time per Hit and P_A in those crews in which the accepted Tank Commander endorses the Gunner.

1. b. ASo_{TC} will correlate negatively with Time per Hit
in crews in which the Tank Commander and Gunner sociometrically
endorse each other.

a. ASo_{TC} will correlate negatively with Travel Time where
the accepted Tank Commander endorses the Driver.

2. b. ASo_{TC} will correlate negatively with Travel Time in
crews in which the Tank Commander and Driver sociometrically
endorse each other.

Definition of Sociometric Endorsement.

The sociometrics required nomination of five to seven men
in order of preference. The average choice of another person placing
him among the five most preferred was used as a cutting score.

Since sociometric preferences tend to change over time, our
hypothesis is exactly applicable only to two phases, namely, the
first and the fifth phase $(T/H_I, T/H_V; TT_I, TT_V)$. However, we
have also combined data over all phases for purposes of this
analysis. Each crew was ranked as best, second best, etc., to
poorest (5th) in its platoon for each of the five phases and the cri-
terion ranks were then summed over all phases to obtain combined
scores for both Time per Hit $(\Sigma\ T/H)$ and Travel Time $(\Sigma\ T/T)$.
This procedure assumes that the crew is competing on equal terms
with other crews within the platoon.

In combining the sociometrics into a single index we defined
endorsement as one person's choice for another in fifth preference
rank or above on at least two of the three sociometrics. Similarly,
a Tank Commander was considered Most Preferred Crew Member
when he received the highest number of weighted ranks in his crew
in two of the three sociometrics.

Results

The first hypothesis is related to the Time per Hit (T/H) criterion and P_A and was stated as two subhypotheses: (a) that ASo_{TC} would correlate negatively with the Time per Hit criterion when the accepted Tank Commander endorses the keyman, here the Gunner (Table 6) and (b) where the Tank Commander and Gunner choose each other. (Table 7) As can be seen from Tables 6 and 7, both subhypotheses 1a and 1b are supported.

Table 6

Correlation of the Time per Hit Criterion with the Tank Commander's ASo Score under a Specified Sociometric Condition

$(TC = MPC \rightarrow G)$

Phase subsequent to sociometric	Criterion	Rho	N	P
I	T/H_I	-.53	6	—
V	T/H_V	-.51	12	.05
Combined	$\Sigma T/H$	-.76	7	.05
I	P_A	-.37	6	—
V	P_A	-.71	12	.01
Combined	P_A	-.60	7	.10

Operational Hypothesis 2a stated that ASo would be negatively correlated with Travel Time, when the accepted Tank Commander endorses the Driver. Table 8 presents correlations pertaining to the Travel Time criterion. Operational Hypothesis 2b could not be tested because of the insufficient number of available crews (N = 4).

We therefore consider the major hypothesis of the validation study as supported, in particular since the uncorrelated Gunnery and Travel Time Criteria give consistent results.

Table 7

Correlation between the Gunnery Criterion with the
ASo of the Tank Commander under a Specified Sociometric Condition
TC $\leftarrow\rightarrow$ G

Phase subsequent to sociometric	Criterion	Rho	N	P
I	T/H_I	-.35	9	-
V	T/H_V	-.32	9	-
Combined	$\Sigma T/H$	-.61	9	.05
I	P_A	-.43	9	-
V	P_A	-.72	9	.02
Combined	P_A	-.7?	9	.02

Table 8

Correlation of the Travel Time Criterion with Tank
Commanders' ASo Score under a Specified Sociometric Condition
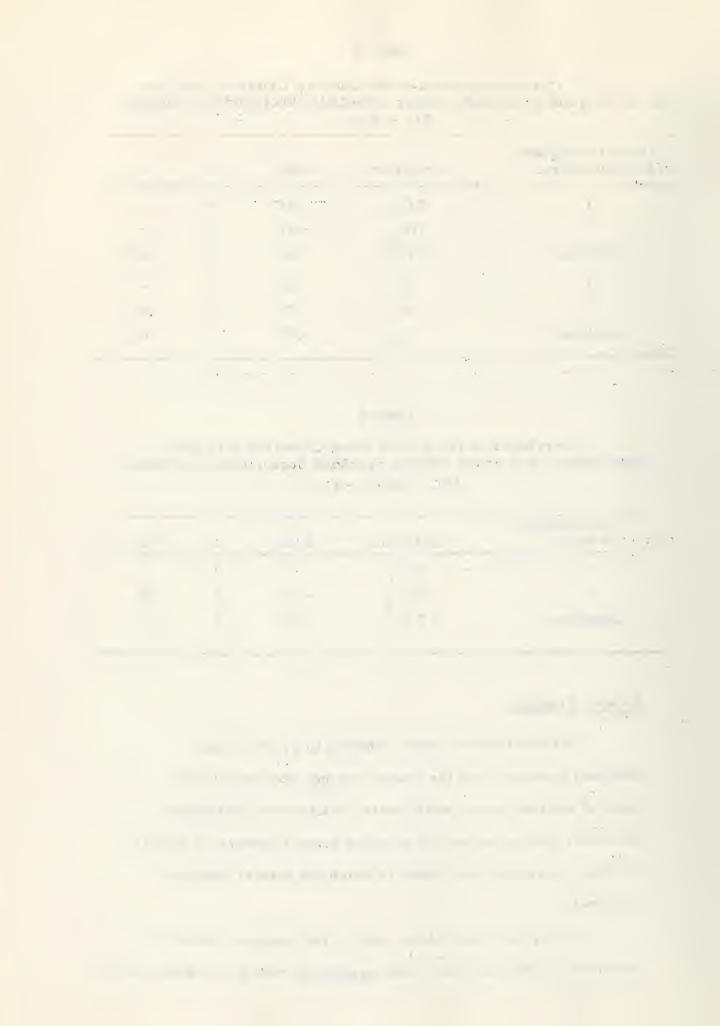(TC = MPC $--\rightarrow$ D)

Sociometrics in Phase	Criterion	Rho	N	P
I	T/T_I	-	2	-
V	T/T_V	-.74	6	.10
Combined	$\Sigma T/T$	-.33	5	-

Related Findings

Further analyses were confined to crews having
accepted leaders since the leader was not accepted in only
eight of the tank crews which were available for validation.
However, groups not having accepted formal leaders do appear
to differ markedly from those in which the formal leader is
accepted.

As we have seen above, ASo of the accepted leader who
endorsed his keyman correlated negatively with group effectiveness

criteria. In addition, Table 9 shows that ASo and effectiveness correlate positively in crews in which the accepted leader does **not** endorse his keyman. This suggests that two separate attitudes of the leader toward his co-workers interact in affecting the performance of his group" (a) the leader's generalized attitude toward co-workers (ASo), and (b) his specific attitude toward his keyman (measured sociometrically).

Table 9

Summary of correlations obtained from bomber and tank crews in which the Leader is Most Preferred Crew Member[*]

Sample	Criterion	Keyman	Leader's Preference for Keyman					
			Positive		Neutral		Negative	
			Rho	N	Rho	N	Rho	N
B-29	RBS	VO/N	-.81	11	-.13	7	.42	7
B-29	%SVC	B	-.52[**]	7	.47[**]	9	.27[**]	7
Tanks	$\Sigma T/H$	G	-.60	6	.11	6	.60	5
Tanks	$\Sigma T/T$	D	-.33	5	.39	6	.43	6

[*] Friedman's χ^2 test (7) indicates that this table departs significantly from randomness.
[**] See Footnote, p. 13

Figure 1 presents the data of Table 9 in graphic form. The correlation between the leader's generalized interpersonal attitude (ASo) and his group's effectiveness is plotted along the vertical axis; the leader's positive, neutral, or negative sociometric rating of his keyman (indicated by +, 0, -, respectively) is plotted on the horizontal axis. The interaction between ASo and sociometric preferences is readily apparent in this figure. ASo and group effectiveness correlate negatively in crews in which the leader endorses his keyman (points labelled "A") but positively in crews where the leader does not endorse his keyman (points labelled "C"). The point labelled "B" identifies

Figure 1. Correlations between leader's ASo and effectiveness plotted against leader's
preference for his keyman for bomber and tank crews

Point A identifies correlations for groups in which leader expresses positive choice for Keyman
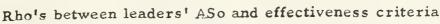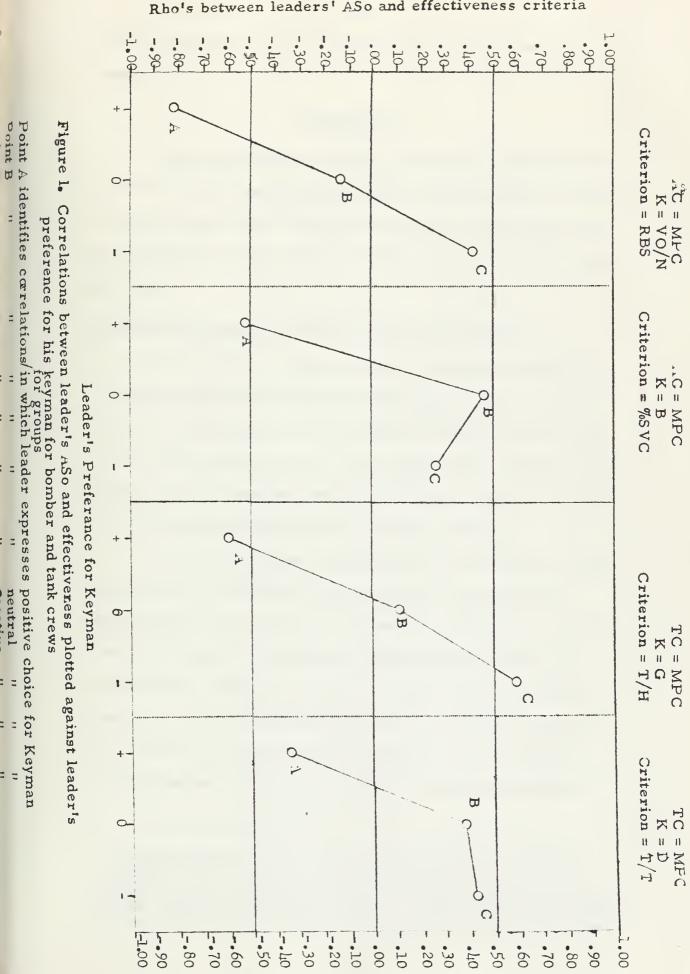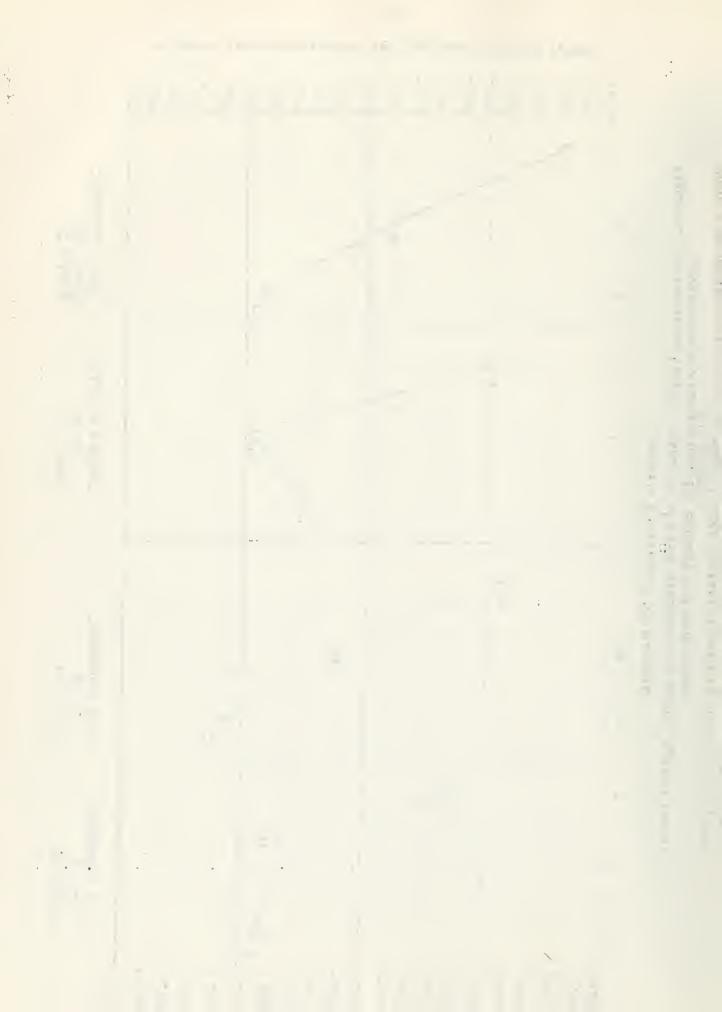Point B " " " " " neutral " " "
Point C " " " " " negative " " "

crews in which the leader's preference for his keyman was neutral.[*]

Discussion

The studies raise a number of problems. In addition to the interaction effect presented above we will consider questions concerning the leader's status in the group and concerning the classification of tasks in terms of the hypotheses to which they give rise.

Interaction between Sociometric Preference and ASo

The studies of bomber and tank crews have yielded results which indicate that effective work groups tend to have accepted leaders (a) who are generally distant toward their co-workers (low ASo) and have a close relationship with their key-men, or (b) who have generally close relations with co-workers but who are distant toward their particular keyman.

In an earlier paper dealing with informal teams we suggested that effective leadership requires a certain distance between the leader and his co-workers (6). The present studies lead to the additional hypothesis that the effective leader can maintain this distance in one of two ways. If he is generally distant, i.e., has a tendency to perceive, and react to, persons in a generally cold and reserved manner, he must compensate for this feeling of distance to others by a feeling of closeness

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[*] Categorization of crews into groups in which the leader's preference was positive, neutral, or negative, was based on available data. The results therefore require further validation; future work may indicate that more or fewer subdivisions provide the most efficient utilization of data for purposes of prediction.

toward his keyman.*

Multiple correlations, using the variables, leader's ASo, sociometric preference (SP) and their product ASo x SP, yielded R's as shown in Table 10.

Table 10

Prediction of three effectiveness criteria by the Assumed Similarity and Sociometric Preference variables, singly, jointly, and in combination with the Assumed Similarity x Sociometric Preference Score

Criterion (1)	N	ASo (2)	SP (3)	$R_{1 \cdot 2\ 3}$	$R_{1 \cdot 2\ 3\ 4}$*
Radar Bombing	22	-.21	-.04	.21	.45
Time per Hit	17	-.30	-.15	.32	.45
Travel Time	17	.12	.15	.20	.30

*Variable 4 is ASo x SP; these scores were obtained by multiplying the standard scores of ASo and SP

In Table 10, neither the multiple correlations nor the increments of $R_{1 \cdot 2\ 3\ 4}$ are statistically significant when considered individually. The beta weights for the product term ASo x SP were -.56, -.33, and -.24 for RBS, T/H, and T/T, respectively. The first two of these weights are considerably greater than the weights for ASo and SP in the RBS and T/H correlations. The third beta weight for ASo x SP is equal to the weight for ASo in the T/T correlation and these two weights are again considerably greater than the weight for SP. This finding is related to the interpretation that we are dealing with a single dimension of emotional distance which is a composite of ASo and sociometric preference. The negative signs show that an increase of the cross product is

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* In terms of the work by Halpin (8), Hemphill (9) and their associates, these may well be the leaders who have high "consideration" as well as initiation-of-structure scores.

**The writer is indebted to Dr. C. F. Wrigley for suggesting the use of the cross product term as a variable and for his assistance in interpretation of the results. It may be noted that this use of the product term is arithmetically identical to that of Saunders' (15) "moderator variable" model.

detrimental to effectiveness, thus again indicating that effective group leaders tend to be persons with high ASo and low Sociometric preference for their keyman, or vice versa.

On the whole, these multiple regressions lend further support to the interpretation that the effective leader's generalized and specific attitudes toward co-workers complexly interact, resulting in an optimum leader-keyman distance. This hypothesized distance may be visualized as the sum of the distance engendered by a generalized attitude (ASo) and of the distance resulting from a particular interpersonal attitude (expressed by sociometric choice). An attempt has been made to present this relationship in Figure 2.

ASo is visualized as an index of the leader's generalized relations to his co-workers. The less similarity the leader assumes, i.e., the lower his ASo, the less approachable will he be in his relations with others. In this figure, this distance is shown as the radius of the circle. The sociometric preference is also visualized as a distance. The higher the leader's preference for his keyman, the closer his psychological distance to him. The less his sociometric preference, the greater the distance between himself and his keyman. This distance is optimal in diagrams b and c. Overly distant or overly close relations are detrimental to group effectiveness. The latter are diagrammed in a and d, respectively.

Most large organizations implicitly or explicitly recognize the importance of social and psychological distance in work relations, and have established elaborate rules for maintaining this distance between leader and follower. Thus the armed forces
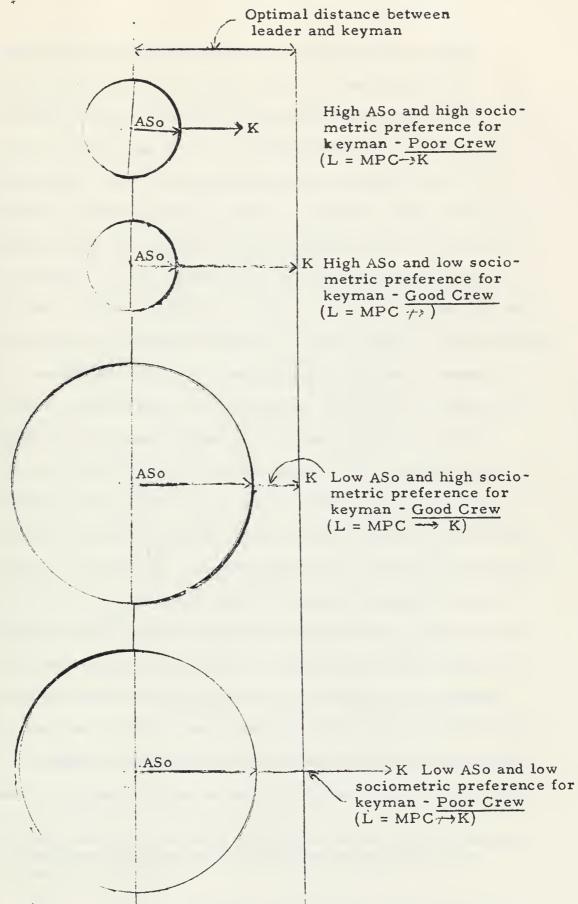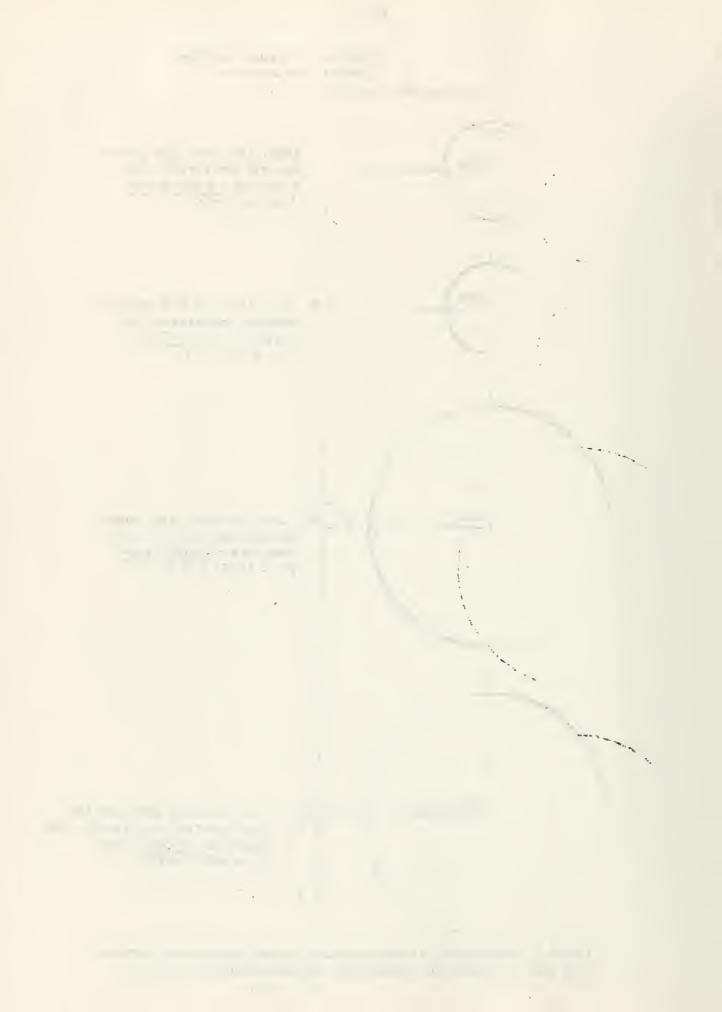
Figure 2. Schematic Representation of the Interaction between ASo and Sociometric Preference in Good and Poor Crews.

separate the senior officer from the junior officer, and the
junior officer from his enlisted men. We may point to the
restricted officers' and NCO messes and washrooms, the of-
ficers' country aboard ship, the Admiral's deck, the periodic
job rotations, and many other rules which operate to restrict
informal contacts between leader and follower. Large industrial
organizations have similar, although perhaps less explicit, rules[*]
in industry. We also find the executive dining room and the em-
ployees' cafeteria, informal sanctions against vice presidents and
bookkeepers playing golf together, and many others. These customs
and institutions, whether by design or not, operate to maintain a
distance between leader and followers. In light of our studies, the
maintenance of such a distance by means of various barriers
appears justified when the leader tends to have generally close
relations with others. These same barriers may be detrimental
in cases where the accepted leader naturally tends to have distant
relations with others: here we would expect poorer group perform-
ance since the extreme distance between the generally reserved
leader who has negative feelings toward his keyman may perhaps
make successful communication too difficult. On the other hand,
the approachable outgoing leader may well become emotionally
too involved with the keyman whom he likes, and he may therefore
have difficulty in making sound decisions involving his subordinate,
and in applying sanctions in the case of poor keyman performance.

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[*] Thus, Katz, et al. report a greater role differentiation between
supervisor and supervisees in high productivity than in low
productivity groups (13).

The leader's status in the group

The relations which we have found in our studies are
limited to groups in which the formal leader is also the group's
informal leader. It is probable that the informal leader status
provides the formal leader with considerable influence and power
over his crew members. Because the group supports his actions,
the leader's demands can be reinforced not only by official sanc-
tions but also by the much more potent pressures which the group
itself might bring to bear on the non-conforming individual. Where
the leader does not have informal leader status another person may
perhaps take over some of his leadership functions as has been sug-
gested by other investigators (1, 12). It is also possible that effective
teams, which do not accept their leaders, utilize the keyman's skill
and the leadership ability of other crew members to a relatively
greater extent. While our data provide some leads, further research
is required to develop theory and methods for predicting the effect-
iveness of these groups.

Categorization of group tasks.

Our studies have been mainly concerned with situations
which seem to require positive, ie., direction-giving leadership
behavior. However, we found in the bomber crew study that the
correlation between Control Time Error and the Aircraft Com-
mander's ASo is in the opposite direction from that obtained in
other studies. While the finding may be due to chance, we are
inclined to believe that Control Time Error requires a receptive
attitude on the part of the Aircraft Commander. If this is the case,

a categorization of group tasks in terms of optimum leader atti-
tudes would be of considerable practical and theoretical importance.
Such studies may well lead to new conceptions of training and place-
ment of potential leaders, a conclusion which is also suggested by
research on Naval Leadership by Shartle, Stogdill, and others
(16, 17). Research on this aspect of the group effectiveness problem
is now under way.

Summary and Conclusions

Two studies are here reported which investigate the re-
lation between the leader's interpersonal attitudes and the effect-
iveness of small military combat crews.

Two types of leader attitudes were considered; a general-
ized attitude toward co-workers, and the attitude toward a specific
crew member. The former is obtained when we ask S to predict
the personality test responses of the persons whom he considers
to be his most and least preferred co-workers. The statistical
comparison of these two predictions yields the interpersonal per-
ception score, Assumed Similarity between Opposites (ASo).
The second attitude measure is concerned with sociometric pref-
erences of the leader for a particular co-worker, namely, the
keyman, or the specialist on the crew who is most directly con-
cerned with the criterion relevant operations.

An exploratory study using 53 B-29 bomber crews led
to the hypothesis that the ASo of the leader would be negatively
correlated with crew effectiveness criteria in groups in which
the accepted leader sociometrically endorsed his keyman,

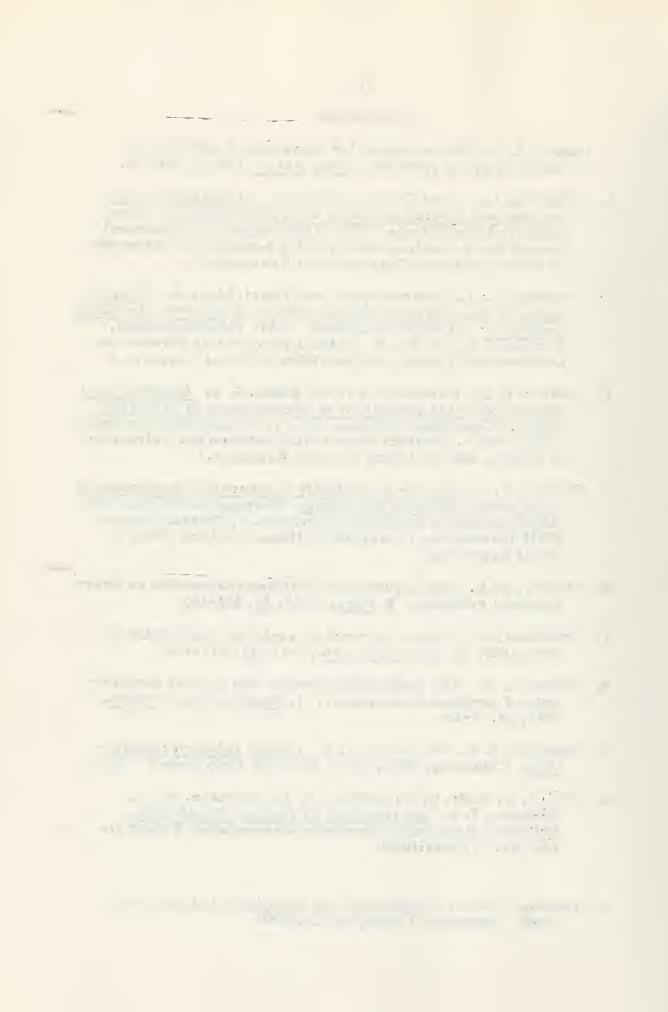or in which leader and keyman mutually chose each other.
In addition, the presence of an interaction effect between the
leader's status, his attitude toward generalized co-workers (ASo)
and his attitude toward his keyman (his sociometric rating of his
keyman) was found, suggesting that the psychological distance
between leader and keyman is related to the effectiveness of
the team.

A validation study was conducted on 25 Army tank crews
which participated in a carefully controlled weapons analysis
experiment. Two uncorrelated criteria were available for the
study. The hypothesis was supported that leaders' ASo scores
correlate negatively with criteria in crews of specified socio-
metric structure. The study also provided corroborating evidence
that the psychological distance between accepted leaders and key-
men, here defined by ASo and sociometric preference, is related
to effective team work.

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